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Isely et al.

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(54) **PORTABLE SAMPLE DISRUPTOR APPARATUS, KITS, AND METHODS**

(71) Applicant: **ZYMO RESEARCH CORPORATION**, Irvine, CA (US)

(72) Inventors: **Nikolas M. Isely**, Moraga, CA (US); **Marc E. Van Eden**, North Tustin, CA (US); **Jonathan K. Brown**, Lake Forest, CA (US)

(73) Assignee: **ZYMO RESEARCH CORPORATION**, Irvine, CA (US)

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C12Q 1/68	(2006.01)
G01N 1/28	(2006.01)
C12N 15/10	(2006.01)
C12M 1/00	(2006.01)
G01N 33/48	(2006.01)
B01F 5/06	(2006.01)
B01F 15/02	(2006.01)
B01L 3/00	(2006.01)

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CPC ***C12N 1/066*** (2013.01); ***C12M 47/06*** (2013.01); ***G01N 1/286*** (2013.01); *B01F 5/0685* (2013.01); *B01F 15/0279* (2013.01); *B01F 2015/0273* (2013.01); *B01L 3/50853* (2013.01); *B01L 2400/0433* (2013.01); *C12M 1/02* (2013.01); *C12N 15/10* (2013.01); *C12N 15/1003* (2013.01); *C12Q 1/6806* (2013.01)

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CPC B01F 15/0279; B01F 2015/0273; B01F 5/0685; B01L 2400/0433; C12M 1/02; C12M 47/06; C12N 15/10; C12N 15/1003; C12N 1/066; G01N 1/286

See application file for complete search history.

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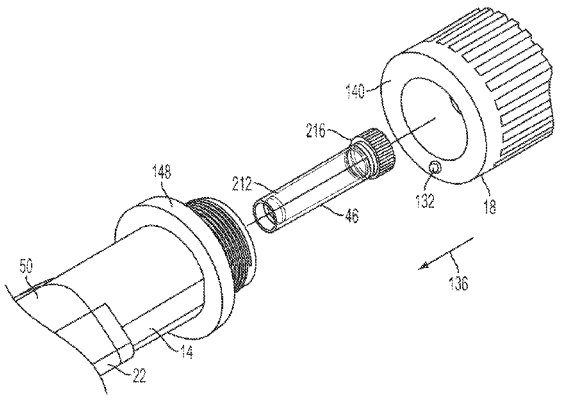
Primary Examiner — Jennifer Wecker

(74) *Attorney, Agent, or Firm* — Parker Highlander PLLC

(57) **ABSTRACT**

Apparatuses, kits, and methods for portable sample disruption (e.g., for encouraging cell lysis).

18 Claims, 8 Drawing Sheets



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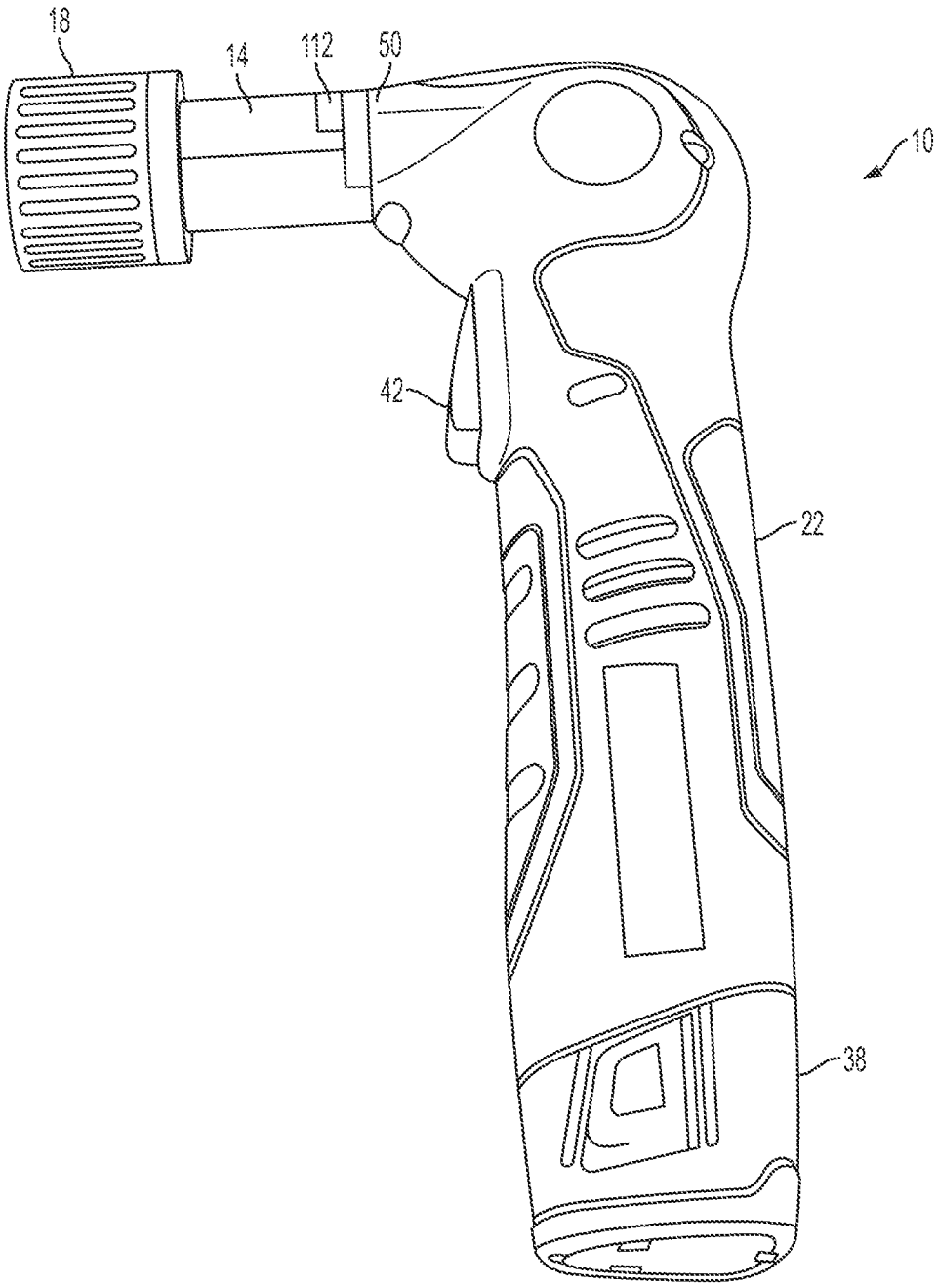

FIG. 1

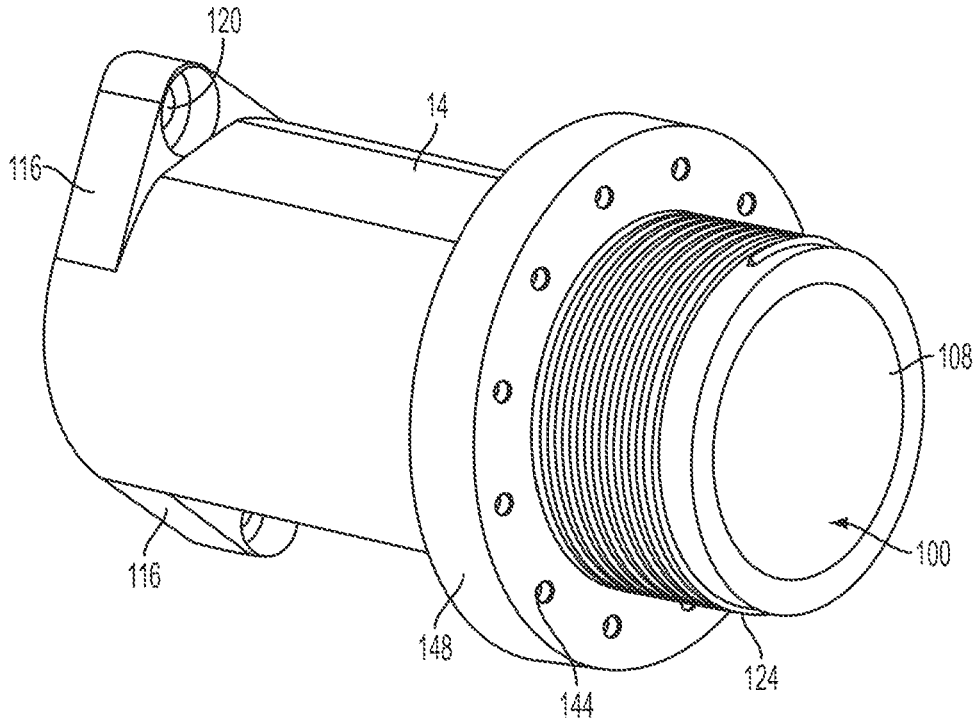
120
14
116
106
116
100
148
144
124

FIG. 2

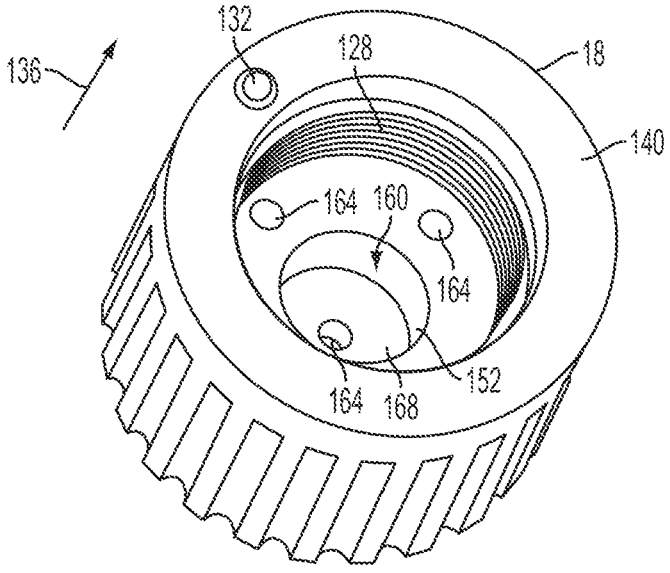
132
128
18
136
140
164
160
164
164
168
152

FIG. 3

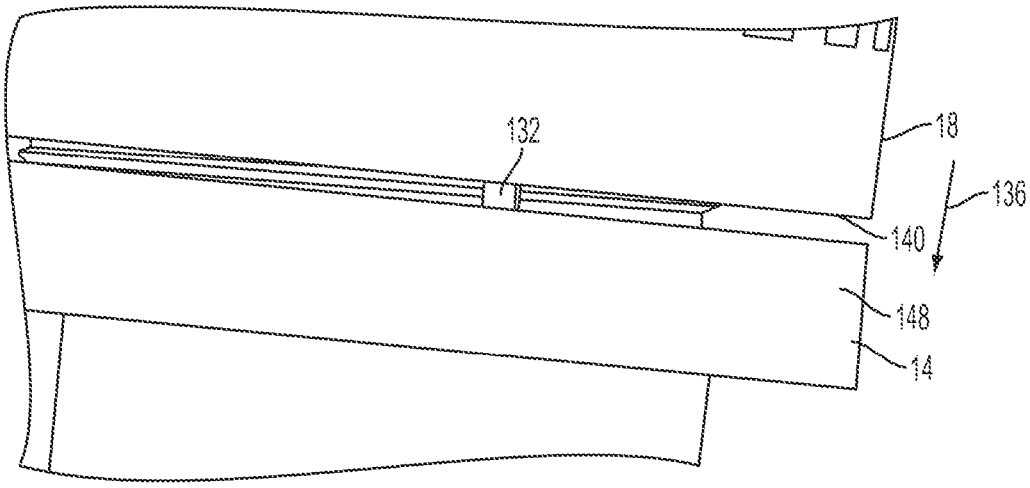

FIG. 4

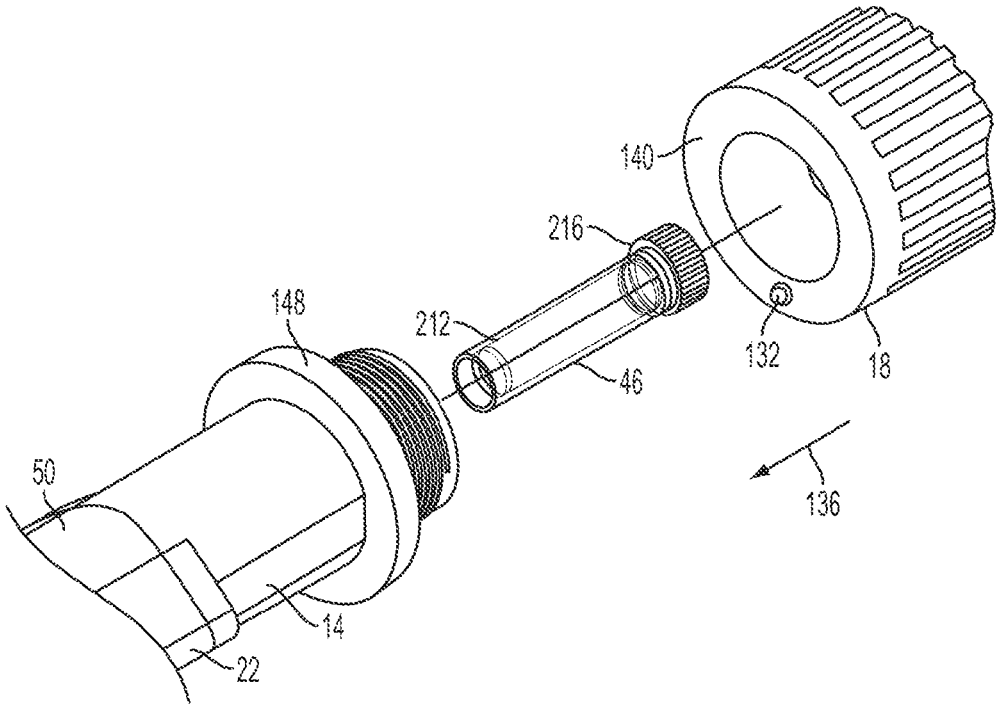

FIG. 5

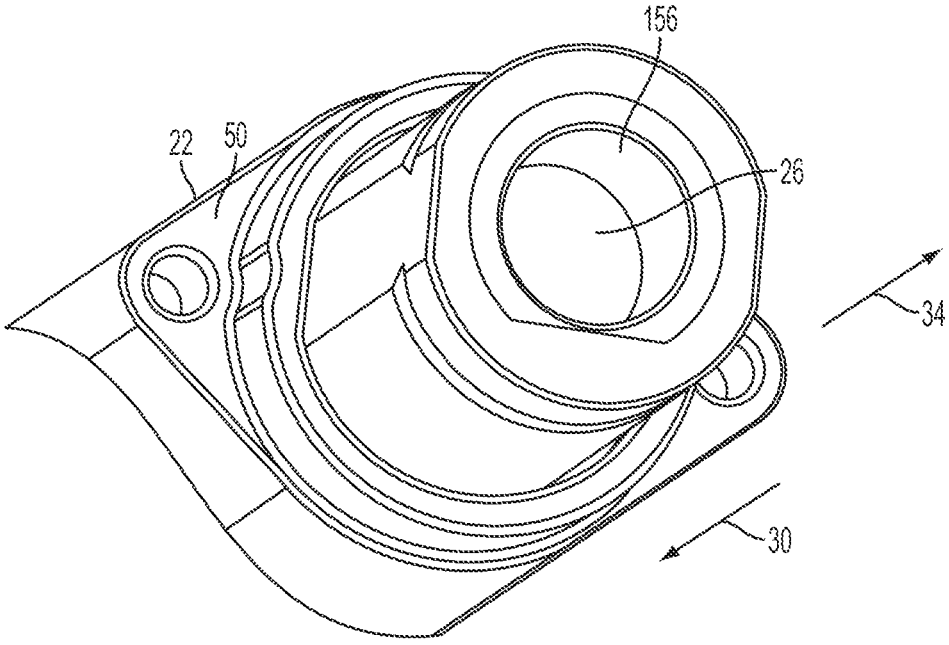

FIG. 6

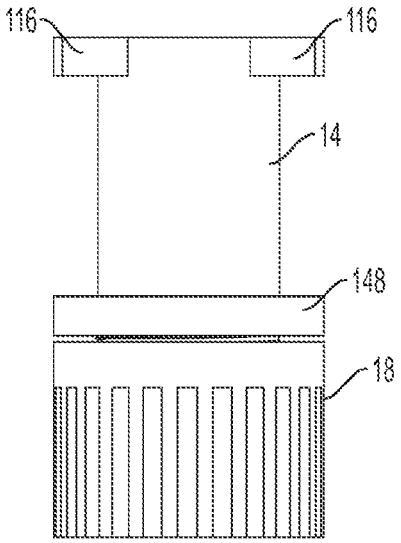

FIG. 7A

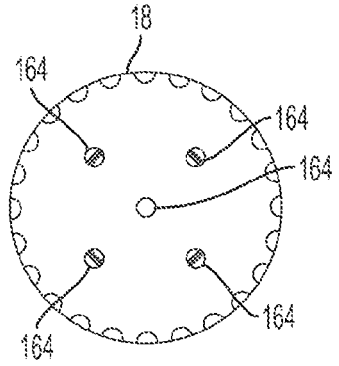

FIG. 7B

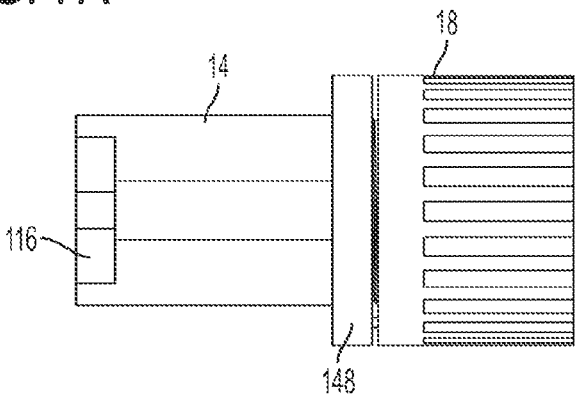

FIG. 7C

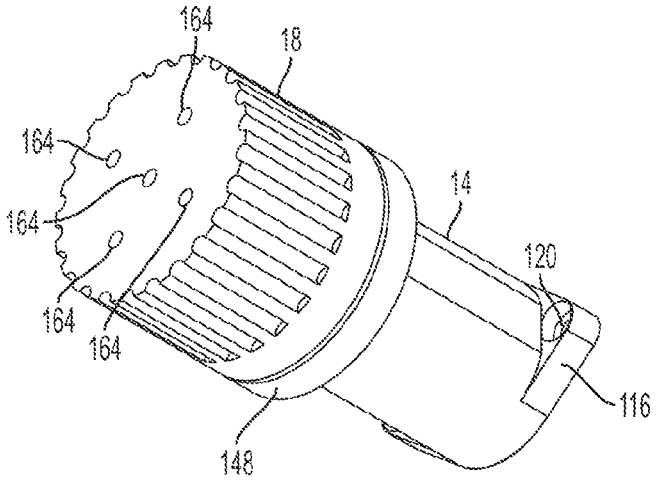

FIG. 7D

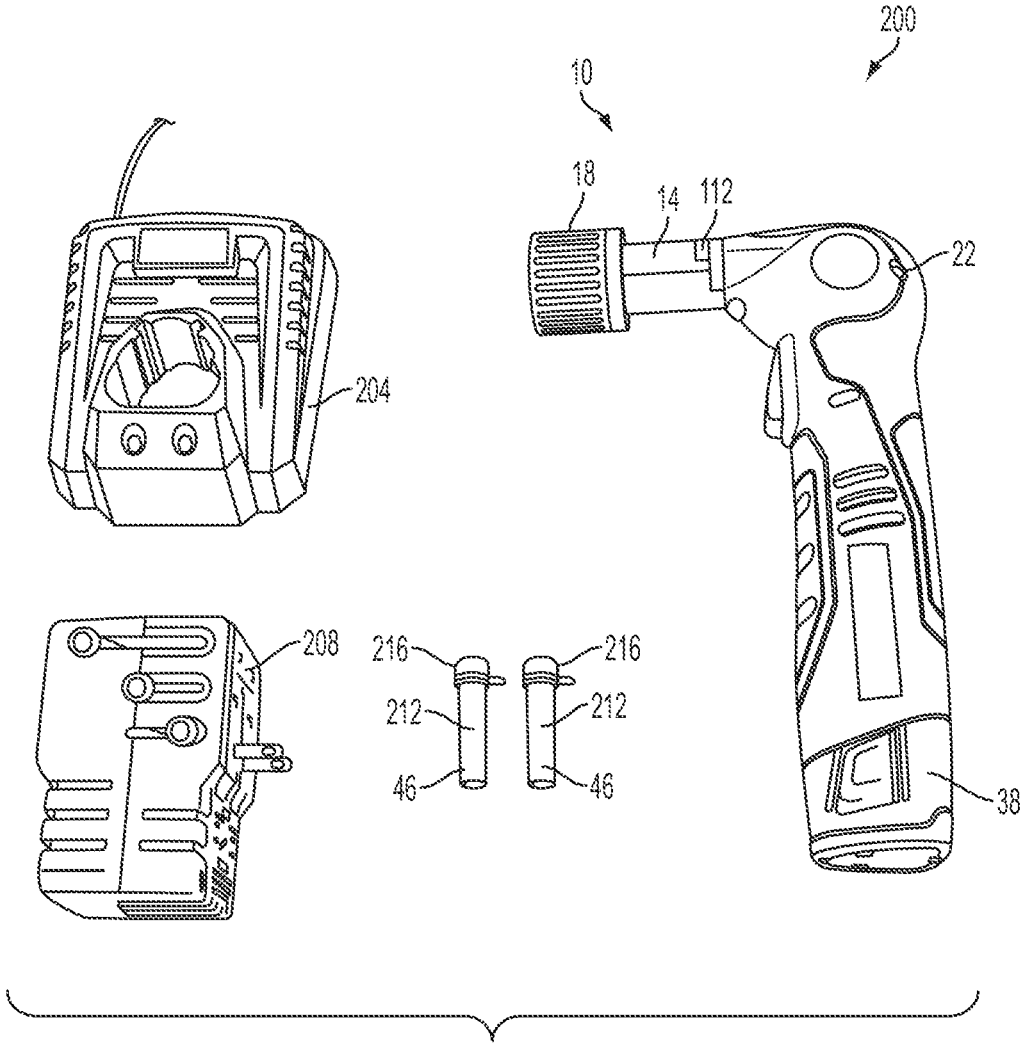

FIG. 8

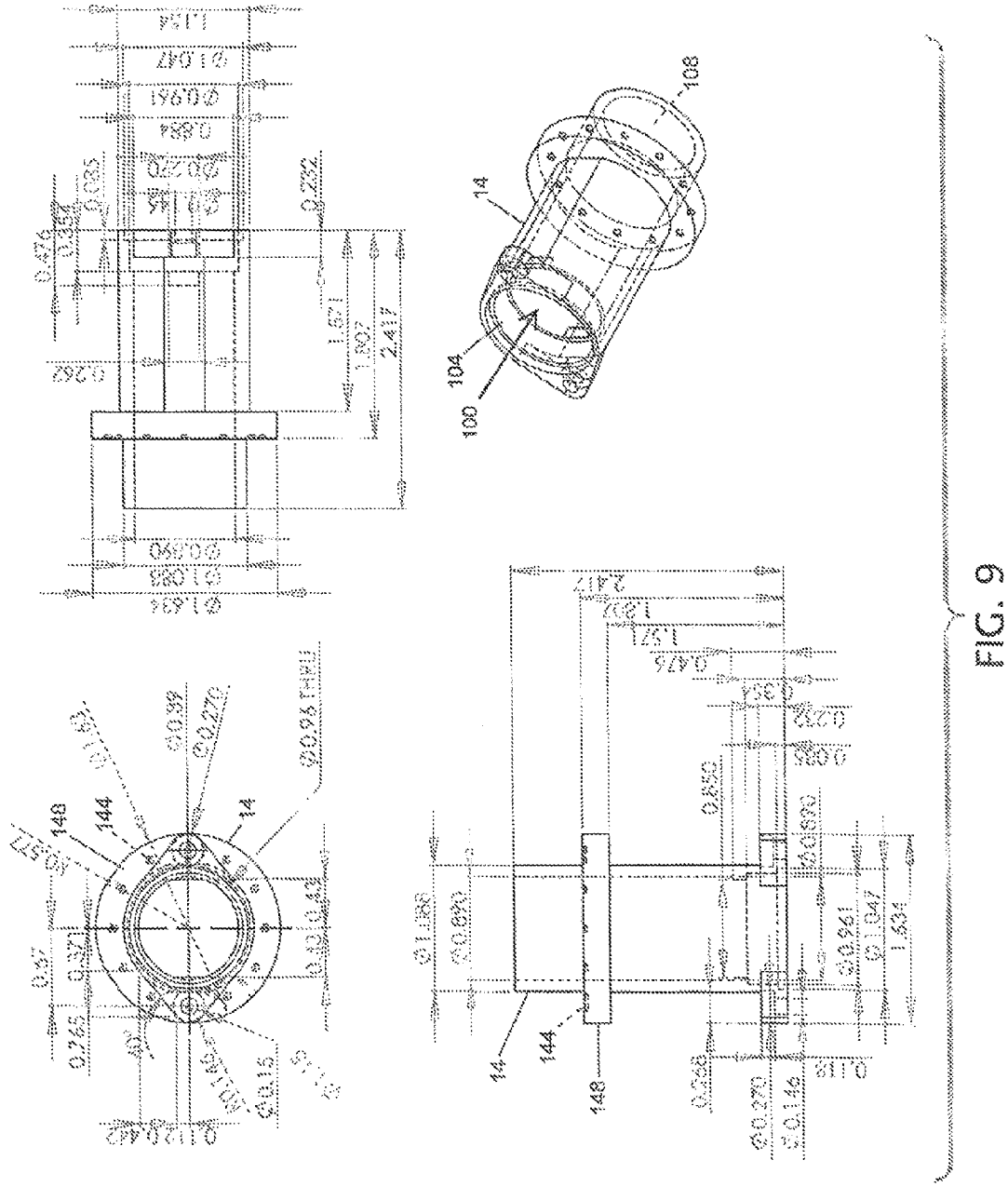

FIG. 9

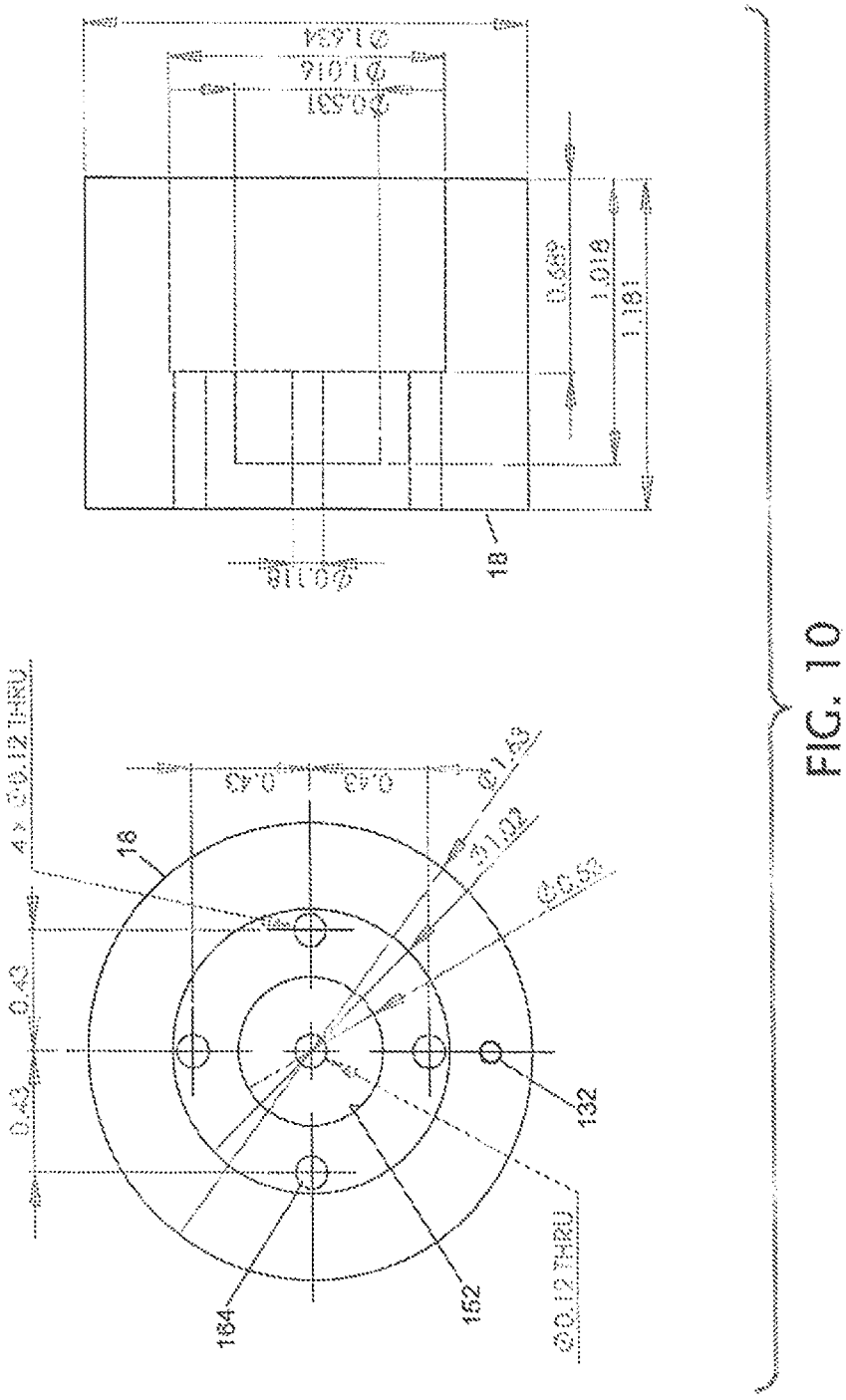
1.181
1.018
18
4 X Ø0.12 THRU
16
0.43
0.43
90°
90°
Ø1.63
Ø1.02
Ø0.63
132
184
162
Ø0.12 THRU

FIG. 10

PORTABLE SAMPLE DISRUPTOR APPARATUS, KITS, AND METHODS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 13/419,178, filed Mar. 13, 2012, which claims priority to U.S. Provisional Patent Application No. 61/452,464, filed Mar. 14, 2011. The entire contents of each of the above-referenced applications are incorporated herein by reference in their entirety.

BACKGROUND

1. Field of the Invention

The present invention relates generally to sample disruption (e.g., for cell lysis). More particularly, but not by way of limitation, the present invention relates to portable or in-field sample disruption.

2. Background Information

Degradation and contamination of biological samples have been obstacles to scientific study, and may be particularly problematic in highly sensitive molecular-analysis techniques. For example, reliability of techniques such as single molecule sequencing and quantitative polymerase chain reaction (PCR) generally depends upon high-quality, unadulterated, biological samples. In a laboratory setting sterile equipment and careful technique can prevent contamination of samples. Likewise, cryogenic freezing and/or limiting exposure to high temperature may be utilized to attempt to maintain the integrity of samples. For collection of biological samples in the field, such as in forensics and environmental science, use of cryogenic freezing is generally too impractical to be employed.

SUMMARY

The present disclosure includes embodiments of apparatuses, kits, and methods.

Embodiments of the present apparatuses comprise: a body defining a chamber having a first end and a second end configured to permit a container (e.g., vial) to be inserted into the chamber, the body configured to be coupled to a device having a piston such that the volume of the chamber can be varied by reciprocating the piston between a retracted position and an extended position; and a cap configured to be coupled to the body such that the cap covers the second end of the chamber; where if the body is coupled to the device, the piston can be reciprocated to vibrate a container (e.g., vial) disposed in the chamber.

Some embodiments of the present apparatuses further comprise: a resilient member coupled to at least one of the cap and the body such that if a container (e.g., vial) is vibrated in the chamber, the resilient member is compressed when the piston is in the extended position. In some embodiments, the body comprises threads, and the cap comprises threads corresponding to the threads of the body for coupling the cap to the body. In some embodiments, the cap comprises a retractable protrusion biased in a bias direction that is toward at least a portion of the body when the cap is coupled to the body; the body comprises a plurality of indents; and the apparatus is configured such that if coupled to the body the cap is rotatable to adjust the length of the chamber between innermost and outermost positions of the cap at which the retractable protrusion of the cap will extend into one of the plurality of indents of the body to resist rotation of the cap relative to the body. In some embodiments, the cap includes a shoulder configured such that if a container (e.g., vial) is disposed in the chamber and the cap is coupled to the body, the shoulder will limit lateral movement of the container (e.g., vial). In some embodiments, the cap includes one or more openings configured to permit fluid communication through the cap if the cap is coupled to the body.

In some embodiments, the body is configured to fit within a rectangular volume of 12 cubic inches. In some embodiments, the body and cap are configured to be coupled together such that the body and cap fit within a rectangular volume of 16 cubic inches. Some embodiments of the present apparatuses further comprise a device having a piston; where the body is coupled to the such that the volume of the chamber can be varied by reciprocating the piston between a retracted position and an extended position. In some embodiments, the device is battery powered. In some embodiments, the device is an auto-hammer.

Some embodiments of the present kits comprise; an embodiment of the present apparatuses, and a battery charger. Some embodiments further comprise: one or more containers (e.g., vials) each sized to be vibrated in the chamber of the body. Some embodiments further comprise: at least one component selected from the group consisting of: earplugs, lysis beads, lysis solutions, an instruction manual, and a battery.

Some embodiments of the present methods comprise: providing an embodiment of the present apparatuses (e.g., comprising a body and a cap, the body defining a chamber having a first end and a second end, and the cap configured to be coupled to the body such that the cap covers the second end of the chamber); and coupling the body to a device having a piston (e.g., such that: the volume of the chamber can be varied by reciprocating the piston between a retracted position and an extended position; and/or the piston can be reciprocated to vibrate a container (e.g., vial) disposed in the chamber).

Some embodiments of the present methods comprise: providing an embodiment of the present apparatuses (comprising a body and a cap, the body defining a chamber having a first end and a second end, and the cap configured to be coupled to the body such that the cap covers the second end of the chamber, where the body is coupled to a device having a piston such that the volume of the chamber can be varied by reciprocating the piston between a retracted position and an extended position); disposing a container (e.g., vial) in the chamber; coupling the cap to the body; and activating the device to vibrate the container (e.g., vial). In some embodiments, the device is held such that the cap is above at least a portion of the device while the device is activated. In some embodiments, the container (e.g., vial) includes a body portion and a lid portion, and the container (e.g., vial) is disposed in the chamber such that at least part of the lid portion of the container (e.g., vial) is disposed between the cap and the body portion of the container (e.g., vial). In some embodiments, the device is activated for at least 30 seconds. Some embodiments further comprise: disposing a sample in the vial prior to disposing the vial in the chamber.

Some embodiments of the present methods comprise: mechanically disrupting a cell sample disposed in a container such that nucleic acid is released from cells in the sample; where mechanically disrupting includes activating a battery-powered device of an apparatus (e.g., one of the present apparatuses) to cause reciprocation of a piston to vibrate the container.

In some embodiments of the present methods, the container contains a sample (e.g., a cell sample). In some embodiments, the container contains a plurality of beads. In some

embodiments, the beads comprise ceramic. In some embodiments, the container contains a lysis solution. In some embodiments, the lysis solution comprises an organic lysis solution. In some embodiments, the sample (e.g., cell sample) comprises soil, fecal matter, or biological tissue. In some embodiments, the container comprises a storage tube.

In any embodiment of the present disclosure, the term "substantially" may be substituted with "within [a percentage] of" what is specified, where the percentage includes 5, 10, and/or 15 percent.

Any embodiment of any of the present systems and/or methods can consist of or consist essentially of—rather than comprise/include/contain/have—any of the described steps, elements, and/or features. Thus, in any of the claims, the term "consisting of" or "consisting essentially of" can be substituted for any of the open-ended linking verbs recited above, in order to change the scope of a given claim from what it would otherwise be using the open-ended linking verb.

Details associated with the embodiments described above and others are presented below.

BRIEF DESCRIPTION OF THE DRAWINGS

The following drawings illustrate by way of example and not limitation. For the sake of brevity and clarity, every feature of a given structure is not always labeled in every figure in which that structure appears. Identical reference numbers do not necessarily indicate an identical structure. Rather, the same reference number may be used to indicate a similar feature or a feature with similar functionality, as may non-identical reference numbers.

FIG. **1** depicts is a perspective view of one of the present portable sample-disruption apparatuses coupled to an auto-hammer.

FIG. **2** depicts a perspective view of a body of the apparatus of FIG. **1**.

FIG. **3** depicts a perspective view of the cap of the apparatus of FIG. **1**.

FIG. **4** depicts an enlarged perspective view of the cap of FIG. **3** coupled to the body of FIG. **2**.

FIG. **5** depicts a perspective exploded view of the apparatus of FIG. **1**.

FIG. **6** depicts an enlarged perspective view of a portion of the auto-hammer of FIG. **1**.

FIGS. **7**A-**7**D depict various enlarged views of the apparatus of FIG. **1**.

FIG. **8** depicts a perspective view of one of the present kits.

FIG. **9** depicts various dimensioned views of one embodiment of the body of FIG. **2**.

FIG. **10** depicts various dimensioned views of one embodiment of the cap of FIG. **3**.

DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

The term "coupled" is defined as connected, although not necessarily directly, and not necessarily mechanically; two items that are "coupled" may be integral with each other. The terms "a" and "an" are defined as one or more unless this disclosure explicitly requires otherwise. The terms "substantially," "approximately," and "about" are defined as largely but not necessarily wholly what is specified, as understood by a person of ordinary skill in the art.

The terms "comprise" (and any form of comprise, such as "comprises" and "comprising"), "have" (and any form of have, such as "has" and "having"), "include" (and any form of include, such as "includes" and "including") and "contain" (and any form of contain, such as "contains" and "containing") are open-ended linking verbs. As a result, a method that "comprises," "has," "includes" or "contains" one or more steps possesses those one or more steps, but is not limited to possessing only those one or more steps. Likewise, a watering system that "comprises," "has," "includes" or "contains" one or more elements possesses those one or more elements, but is not limited to possessing only those elements. For example, in a watering system that comprises one or more surfaces and a platform, the watering system includes the specified elements but is not limited to having only those elements. For example, such a watering system could also include a drainage structure.

Further, a device or structure that is configured in a certain way is configured in at least that way, but it can also be configured in other ways than those specifically described.

At least some embodiments of the present apparatuses, kits, and methods relate to portable apparatuses (e.g., battery-powered and/or compact apparatuses) for disrupting cell samples (e.g., for cell lysis). Samples obtained in the field may be difficult to transport to a lab for analysis in such a way that degradation of the sample is prevented or reduced. At least some embodiments of the present apparatuses, kits, and methods permit (i) rapid processing of a sample into a stabilizing buffer that can prevent or reduce sample degradation; (ii) rapid processing in a way that avoids or reduces the likelihood of contamination (which is generally difficult to achieve outside of the laboratory setting); and/or (iii) rapid processing with an apparatus that is easily transportable and efficient to operate in the field.

Referring now to the drawings, and more particularly to FIGS. **1**-**10**, shown therein and designated by the reference numeral **10** is one embodiment of the present portable sample-disruption apparatuses. In the embodiment shown, apparatus **10** comprises a body **14**, and a cap **18** configured to be coupled to body **14**. Body **14** and/or cap **18** may comprise any suitable material, such as, for example, one or more polymers (e.g., polyamide (also known as NYLON), polyoxymethylene (POM) (also known as acetal or DELRIN), acrylonitrile butadiene styrene (ABS), polyvinyl chloride (PVC)), and/or one or more metals (e.g., aluminum, stainless steel, titanium, alloys, and the like). Body **14** and cap **18** may comprise the same material(s) and/or may comprise different materials. For example, in one embodiment, body **14** comprises polyoxymethylene or acetal, and cap **18** comprises ABS.

As also shown, body **14** is configured to be coupled to device **22** having a piston **26** configured to reciprocate between a retracted position (innermost position in direction **30**) and an extended position (outermost position in direction **34**). Device **22** may, for example, be an auto-hammer (e.g., such as is available from Sears Brands LLC under the CRAFTSMAN brand, U.S.A. under the name "Craftsman 11818 Nextec 12-volt Lithium-Ion Cordless Hammerhead Auto Hammer"). In the embodiment shown, device **22** is battery powered, and comprises a removable battery (e.g., battery pack) **38**. In other embodiments, battery pack **38** may not be removable. In the embodiment shown, device **22** also includes a trigger **42** configured to be depressed to activate device **22** and thereby reciprocate piston **26**. In the embodiment shown, device **22** is configured such that activation of device **22** will not translate to reciprocation of piston **26** unless some force is applied to piston **22** in direction **30** (e.g., to engage the piston with the internal drive mechanism (not shown) of device **22** to cause the piston to be drive in direction **34** and/or direction **30**). In other embodiments, piston **26** may reciprocate whenever device **22** is activated (e.g., regardless

of whether pressure is applied to piston **26** in direction **30**). As used in this disclosure, "reciprocate" includes alternating motion of piston **26** in directions **30** and **34**, and does not require that the piston is driven in both directions (e.g., the piston may be driven in direction **34** and simply recoil in direction **30**), nor that the piston travels at the same speed in both of directions **30** and **34** (e.g., in a sinusoidal fashion).

In the embodiment shown, apparatus **10** is configured as a portable, hand-held device, that can be used for vigorous cell disruption outside of a laboratory setting (e.g., in remote locations and in various weather conditions). For example, apparatus **10** can be used as described in more detail below to disrupt cells in and/or from samples (e.g., of yeast, bacteria, plant, soil, fecal, animal tissue, and the like). Likewise, in the embodiment shown, apparatus **10** is configured for use in nearly any location (e.g., if battery **38** is sufficiently charged), and in various weather conditions, for rapid processing of sample collections (e.g., to preserve and improve stability of processed samples). In the embodiment shown, apparatus **10** is configured to receive a container **46** (e.g., a **2**-milliliter (mL) vial or "tube") within body **14** for disruption of a sample disposed in the container, as described in more detail below. Containers such as 2-mL vials are known, and are available with "skirted" or pointed bottoms. In some embodiments of the present apparatuses and methods, vials with skirted bottoms are used or included. In some embodiments, the container comprises a storage tube. In the embodiment shown, trigger **42** can be depressed for any desired length of time for disruption of a sample, permitting customization and individual control over the duration of sample disruption. In some embodiments, device **22** includes a timer (e.g., a timer circuit) configured to enable activation of device **22** for pre-set durations (e.g., 30, 45, 60, 90, 120, and/or 180 seconds).

In the embodiment shown, body **14** defines a chamber **100** having a first end **104** and a second end **108**. In the embodiment shown, second end **108** of chamber **100** is configured to permit a vial **46** to be inserted into chamber **100**. Body **14** is configured to be coupled to (and is shown coupled to) device **22**. For example, in the embodiment shown, device **22** includes a coupling portion **50** to which body **14** is configured to correspond and be coupled (e.g., via screws **112**). In the embodiment shown, body **14** includes flange portions **116** extending from opposite lateral sides of the body, and including holes **120** positioned to align with matching holes in attachment portion **50** of device **22**. Other embodiments may include only a single flange portion (e.g., extending around the entire perimeter of the body). In the embodiment shown, screws **112** comprise machine screws with 10-32 threads having a length of approximately 0.75 inches, such as, for example, machine screws configured to be driven by an Allen or star wrench or bit. Other embodiments may include any suitable fasteners that couple body **14** to device **22** such that apparatus **10** can function as described in this disclosure. In the embodiment shown, cap **18** is configured to be coupled to body **14** such that cap **18** covers second end **108** of chamber **100**. Apparatus **10** is configured such that, if body **14** is coupled to device **22**, as shown, piston **26** can be reciprocated (e.g., by depressing trigger **42**) to vibrate a vial **46** that is disposed in chamber **100** (e.g., with cap **18** coupled to body **14** to cover second end **108** and retain the vial in the chamber).

In the embodiment shown, body **14** comprises threads **124**, and cap **18** comprises threads **128** corresponding to threads **124** for coupling the cap to the body. In the embodiment shown, cap **18** is configured such that if coupled to body **14**, cap **18** is rotatable to adjust the distance between piston **26** and cap **18** (e.g., to accommodate vials of different lengths). In the embodiment shown, cap comprises a retractable protrusion **132** biased in a bias direction **136** (that is toward at least a portion of body and/or first end **104** of cavity **100**) when the cap is coupled to the body. Retractable protrusion **132** need not be entirely retractable (e.g., may not be capable of retracting below bottom surface **140** of cap **18**) and/or may be entirely retractable (e.g., may be capable of retracting below bottom surface **140**). In the embodiment shown, bias direction **136** is substantially parallel to the central longitudinal axis of cavity **100**. In other embodiments, bias direction may be non-parallel to the central longitudinal axis of cavity **100**. In the embodiment shown, retractable protrusion **132** comprises a ball catch in which a ball is biased in bias direction **136** by a spring (not shown), such that the ball catch extends beyond surface **140** in the absence of a force compressing the biasing spring.

In the embodiment shown, body **14** comprises a plurality of indents **144**. More particularly, in the embodiment shown, body **14** includes a flange **148** around at least a portion of a perimeter of the body, and indents **144** are disposed on flange **148** at equiangular intervals around the body. In this embodiment, apparatus **10** is configured such that if coupled to body **14**, cap **18** is rotatable to adjust the length of the chamber between innermost and outermost positions of the cap at which retractable protrusion **132** will extend into one of indents **144** to resist rotation of the cap relative to the body. For example, the outermost position of the cap is the position of the cap at which the portion of protrusion **132** extending into one of the indents **144** is sufficient to resist rotation of the cap relative to the body, and the innermost position of the cap is the position at which the cap is prevented (e.g., by surface **140** and flange **148**, protrusion **132** and flange **148**, and/or by a vial **46** in cavity **100**) from being rotated or any closer to the body (e.g., flange **148**).

In the embodiment shown, cap **18** includes a shoulder **152** (in the interior of the cap) configured such that if a vial **46** is disposed in chamber **100** and cap **18** is coupled to body **14**, shoulder **152** will limit lateral movement of the vial (e.g., will maintain sufficient alignment between the vial and piston **26**). Similarly, in the embodiment shown, device **3** includes a shoulder **156** (that extends around and beyond piston **26**) configured such that if a vial **46** is disposed in chamber **100** and cap **18** is coupled to body **14**, shoulder **152** will limit lateral movement of the vial (e.g., will maintain sufficient alignment between the vial and piston **26**). In other embodiments, shoulder **156** may be included in body **100** (e.g., may be defined by body **14**), such as, for example, between first end **104** and second end **108** of cavity **100** (e.g., at or near first end **104**). As shown, shoulder **152** defines a central portion **160** within the perimeter of shoulder **152**. The distance between central portion **160** and bottom surface **140** is greater than the distance between shoulder **152** and bottom surface **140**, such that in use, a vial **46** extends within the perimeter of shoulder **152**.

In the embodiment shown, cap **18** also includes one or more openings **164** configured to permit fluid communication through the cap if the cap is coupled to the body. For example, as noted above, reciprocation of piston **26** varies the volume of chamber **100** such that when the piston is extended, the pressure in chamber **100** could increase beyond an acceptable level. Openings **164** are configured to permit pressure in the chamber to equalize to pressure outside the chamber. In the embodiment shown, cap **18** includes a central opening **164** in central portion **160** (within the perimeter of shoulder **152**), and four peripheral openings outside the perimeter of shoulder **152**. Other embodiments may include openings **164** in any suitable number or configuration.

In the embodiment shown, apparatus **10** further comprises a resilient member **168** coupled to at least one of cap **18** and body **14** such that if a vial **46** is vibrated in chamber **100** (with cap **18** coupled to body **14**), resilient member **168** is compressed when piston **26** is in the extended position. For example, in the embodiment shown, resilient member **168** comprises a resilient washer (e.g., comprising rubber, polyurethane, or any other suitably resilient material) disposed in central portion **160**. In some embodiments, resilient member **168** is a rubber washer having an outer diameter of ½ inch, an inner diameter of 3/16 inch, and an uncompressed (relaxed) thickness of 1/16 inch.

As noted above, in the embodiment shown, apparatus **10** is configured to be portable and compact. For example, in the embodiment shown, body **14** is configured to fit within a rectangular volume of 12 cubic inches (e.g., a rectangular box with dimensions of 2 inches by 2 inches by 3 inches), or smaller (e.g., 10 cubic inches, 8 cubic inches, or less). By way of another example, in the embodiment shown, body **14** and cap **18** are configured to be coupled together such that body **14** and cap **18** fit within a rectangular volume of 16 cubic inches, or smaller (e.g., 12 cubic inches, 10 cubic inches, or less).

Some embodiments of the present methods comprise: coupling one of the present apparatuses (e.g., **10**, comprising body **14** and cap **18**, the body defining a chamber having a first end and a second end, and the cap configured to be coupled to the body such that the cap covers the second end of the chamber) to a device (e.g., **22**) having a piston (e.g., **26**), such that the volume of the chamber (e.g., **100**) can be varied by reciprocating the piston between a retracted position and an extended position; and the piston can be reciprocated to vibrate a vial disposed in the chamber. For example, in one embodiment, a device **22** is modified by creating or enlarging holes in connection portion **50** (to correspond to holes **120** and screws **112**). Holes that are created or enlarged in device **22** may be pre-threaded, or may be threaded by insertion of screws **112** (e.g., if screws **112** are self-tapping).

Some embodiments of the present methods comprise: mechanically disrupting a cell sample disposed in a container (e.g., **46**) such that nucleic acid is released from cells in the sample; where mechanically disrupting includes activating a battery-powered device (e.g., **22**) of an apparatus (e.g., **10**) to cause reciprocation of a piston (e.g., **26**) to vibrate the container.

Some embodiments of the present methods comprise: providing an embodiment of the present apparatuses (e.g., **10**, with body **14** coupled to a device such as, for example, device **22**); disposing a vial (e.g., **46**) in the chamber of the apparatus; coupling the cap (e.g., **18**) to the body (e.g., **14**); and activating the device (e.g., **22**) to vibrate the vial. In some embodiments, the device (and/or the apparatus) is held such that the cap (e.g., **18**) is above at least a portion of the device while the device is activated. For example, the device can be held such that the body and cap are oriented vertically with the cap above the body (and such that the vial in the chamber is also oriented vertically). As illustrated, vials **46** each can include a body portion **212** and a lid portion **216**. In some embodiments of the present methods, the vial is disposed in chamber **100** such that at least part of lid portion **216** of the vial is disposed between the cap and the body portion of the vial (e.g., such that lid portion **216** is adjacent cap **18**, and/or within shoulder **152** in central portion **160** of the cap).

In some embodiments of the present methods, the vial can contain: a sample (e.g. a soil sample), a plurality of beads (e.g., lysis beads), and/or a lysis solution (e.g., an organic lysis solution). In some embodiments of the present methods, the device is activated for at least 30 seconds (e.g., any of the durations mentioned above). Some embodiments of the present methods comprise disposing a sample in the vial prior to disposing the vial in the chamber. For example, samples (e.g., cell samples) can comprise soil, fecal matter, or biological tissue (fungal/bacterial, tissue & insect, plant/seed, and the like). Various test kits for DNA and RNA testing and sample preparation from Zymo Research Corporation.

FIG. **10** depicts on embodiment of the present kits **200**. In the embodiment shown, kit **200** comprises an apparatus **10** with device **2**, and a battery charger **204** configured to charge battery **38**. In some embodiments, the present kits may also comprise one or more (e.g., two) vials **46**, each sized to be vibrated in chamber **100** of body **14**. In some embodiments, kit **200** further comprises at least one component selected from the group consisting of: earplugs (not shown), lysis beads and/or lysis solutions (e.g., lysis solutions and/or ceramic lysis beads, such as, for example, those available from Zymo Research Corporation, California, U.S.A.), an instruction manual, and a battery **38** (e.g., an extra or second battery). In some embodiments, kit **200** can also include a converters **208** configured to convert available power (e.g., AC power) in various locations (e.g., international locations with varying standards for power delivery). In some embodiments, vials **46** may contain lysis beads (not shown), such as, for example, a plurality of 2 millimeter beads and/or a plurality of 0.5 millimeter beads (e.g., 5 2 mm beads and 5-0.5 mm beads).

The various illustrative embodiments of devices, systems, and methods described herein are not intended to be limited to the particular forms disclosed. Rather, they include all modifications and alternatives falling within the scope of the claims. For example, the caps of the present apparatuses can be configured to be coupled to the bodies of the present apparatuses by any suitable structure (e.g., interlocking tabs and grooves).

The claims are not intended to include, and should not be interpreted to include, means-plus- or step-plus-function limitations, unless such a limitation is explicitly recited in a given claim using the phrase(s) "means for" or "step for," respectively.

The invention claimed is:

1. An apparatus comprising:

a body defining a chamber having a first end and a second end configured to permit a container to be inserted into the chamber;

a device having a piston such that the volume of the chamber is configured to be varied by reciprocating the piston between a retracted position and an extended position, wherein the body is coupled to the device;

a cap coupled to the body such that the cap covers the second end of the chamber; where:

the piston is configured to be reciprocated to vibrate a container disposed in the chamber;

the body comprises threads, and the cap comprises threads corresponding to the threads of the body for coupling the cap to the body;

the cap comprises a retractable protrusion biased in a bias direction that is toward at least a portion of the body when the cap is coupled to the body;

the body comprises a plurality of indents; and

the cap is configured to be rotated in order to adjust the length of the chamber between an innermost and an outermost position of the cap at which the retractable protrusion of the cap will extends into one of the plurality of indents of the body to resist rotation of the cap relative to the body.

2. The apparatus of claim 1, further comprising:
a resilient member coupled to at least one of the cap and the body such that if a container is vibrated in the chamber, the resilient member is compressed when the piston is in the extended position.

3. The apparatus of claim 1, where the cap includes a shoulder configured such that if a container is disposed in the chamber and the cap is coupled to the body, the shoulder will limit lateral movement of the container.

4. The apparatus of claim 1, where the cap includes one or more openings configured to permit fluid communication through the cap if the cap is coupled to the body.

5. The apparatus of claim 1, where the device is battery powered, and where the apparatus further comprises a battery charger configured to charge a battery for the device.

6. The apparatus of claim 1, further comprising:
one or more containers each sized to be vibrated in the chamber of the body.

7. A method comprising:
providing the apparatus of claim 1;
coupling the body of the apparatus of claim 1 to a device having a piston such that:
the volume of the chamber is varied by reciprocating the piston between a retracted position and an extended position; and
the piston is reciprocated to vibrate a container disposed in the chamber.

8. The method of claim 7, where the apparatus is an apparatus of claim 1.

9. A method comprising:
providing an apparatus comprising a body and a cap, the body defining a chamber having a first end and a second end, and the cap is configured to be coupled to the body such that the cap covers the second end of the chamber, where the body is coupled to a device having a piston such that the volume of the chamber is varied by reciprocating the piston between a retracted position and an extended position; disposing a container in the chamber; coupling the cap to the body; and activating the device to vibrate the container, where:
the body comprises threads, and the cap comprises threads corresponding to the threads of the body for coupling the cap to the body;
the cap comprises a retractable protrusion biased in a bias direction that is toward at least a portion of the body when the cap is coupled to the body;
the body comprises a plurality of indents: and
the cap is rotatable to adjust the length of the chamber between an innermost and an outermost position of the cap at which the retractable protrusion of the cap will extends into one of the plurality of indents of the body to resist rotation of the cap relative to the body.

10. The method of claim 9, where the device is held such that the cap is above at least a portion of the device while the device is activated.

11. The method of claim 9, where the container contains at least one of: a sample,
a plurality of beads, and
a lysis solution.

12. The method of claim 9, where the apparatus is an apparatus of claim 1.

13. A method comprising:
mechanically disrupting a cell sample disposed in a container such that nucleic acid is released from cells in the sample, where mechanically disrupting includes:
inserting the container into a chamber of a body, wherein the chamber comprises a first end and a second end;
coupling a cap to the second end of the chamber via threads on the cap;
activating a battery-powered device of an apparatus to cause reciprocation of a piston to vibrate the container, where:
the body is coupled to the battery-powered device;
the body comprises threads, and the cap comprises threads corresponding to the threads of the body for coupling the cap to the body;
the cap comprises a retractable protrusion biased in a bias direction that is toward at least a portion of the body when the cap is coupled to the body;
the body comprises a plurality of indents; and
the cap is rotatable to adjust the length of the chamber between an innermost and an outermost position of the cap at which the retractable protrusion of the cap will extends into one of the plurality of indents of the body to resist rotation of the cap relative to the body.

14. The method of claim 13, where the container contains a plurality of beads.

15. The method of claim 13, where the container contains a lysis solution.

16. The method of claim 13, where the cell sample comprises soil, fecal matter, or biological tissue.

17. The method of claim 13, wherein the container comprises a storage tube.

18. The method of claim 13, where the apparatus comprises an apparatus of claim 5.

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